I. *Two Letters from Mr.* Stephen Gray, *F. R. S. to* C. Mortimer, *M. D. Secr. R. S. containing farther Accounts of his* Experiments *concerning* Electricity.

LETTER I.

SIR,

ACCORDING to my Promiſe, I herein give an Account of what farther I have diſcover'd relating to Electrical Attraction, which I ſhould have done ſooner, but was willing to ſee what farther Improvement I could make to thoſe Experiments, at my Return to *London*, which were begun in the Country.

About the latter End of *Auguſt*, being at Mr. *Wheler*'s, after having repeated the Experiment of making Sulphur attract Leaf-Braſs *in vacuo*, Mr. *Wheler* having a very good Air-Pump of the larger Sort, made by Mr. *Hauksbee*, we ſuſpended from the Top of a Receiver, which was firſt exhauſted of Air, a white Thread that hung down to about the Middle of the ſame: Then the Receiver being well rubbed, the Thread was attracted by it vigorouſly. When it was at reſt, and hung perpendicular, the Tube was rubbed, and being held near the Receiver, the Thread was attracted towards that Side of it; if the Tube was removed ſlowly, the Thread returned to the Centre of the Receiver, but when moved ſwiftly, the Thread

was attracted by the oppoſite Side of the Receiver: If the Hand was held near the Receiver, and moved haſtily from it, the Thread was attracted by the oppoſite Side, as before. This ſeemed at firſt difficult to account for; but upon farther Conſideration, we concluded it proceeded from the Motion of the Air made by the Tube, and in the other Caſe by that of the Hand, which took off the Attraction from that Side, and not on the other Side; ſo that, as Mr. *Wheler* very well expreſſed it, by this Means the Balance of the Attraction was taken off.

We made another Experiment by ſuſpending a Thread on the Top of a ſmall Receiver, and whelming a large one over it; then by firſt rubbing this, and holding the rubb'd Tube near it, the Thread in the middle Receiver was attracted to that Side of it where the Tube was held.

An Experiment, ſhewing that Attraction *is communicated through* opacous *as well as* tranſparent *Bodies, not* in vacuo.

There was taken a large Hand-Bell, the Clapper being firſt taken out, and a Cork ſuſpended by a Thread from the Top of the Bell, the Cork being ſmeared over with Honey: Then the Bell was ſet on a Piece of Coach-Glaſs, which had been well rubbed, on which the Leaf-Braſs was laid; then the Tube being rubbed, and held near the Handle of the Bell, and afterwards near the Top and Side of the ſame, the Bell being taken off, there were ſeveral Pieces of the Leaf-Braſs ſticking to the honey'd Cork that had been attracted by it: It appeared alſo that ſome others of

of them had been attracted by the Bell, being removed from the Places they were left in when covered by it.

Some time after Mr. *Wheler* told me of an Experiment he had made *in vacuo*, when I was gone from him. He took a ſmall Receiver, and in it ſuſpended a Thread, and over this four other Receivers, all exhauſted, and the Thread was attracted through all the five Receivers, and he thought the Attraction was rather ſtronger than before, when a ſingle Receiver only was made uſe of; but inſtead of wet Leather, he made uſe of a Cement I had recommended to him, *viz.* Bees-Wax and Turpentine, which was what Mr. *Boyle* made uſe of in his Experiments with the Air-Pump, and that, as I had told him, it was my Opinion the Attractions would be much ſtronger, the Steams of the wet Leather taking off ſome of the attracting Force.

I ſhall now proceed to give ſome Account of the Experiments made at Mr. *Godfrey's*; the firſt of which was giving an Attraction by the Tube to a Boy ſuſpended on Hair-Lines, and that by the Intervention of a Line of Communication, the attractive Vertue paſſes to another Boy that ſtands at ſeveral Feet diſtant from him. But before I go any farther, it may not be improper to give an Account of that Experiment of the attractive Power that is communicated to the Boy ſtanding on Roſin; which though the Society have ſeen the Experiment, I have not given you any Account of it in Writing.

June the 16th, 1731, in the Morning, I made the following Experiment on the Boy mentioned, cauſing him to become Attractive by ſuſpending

him on Hair-Lines. There was taken two Pieces of white Roſin made into round flat Cakes of ſomewhat more than eight Inches Diameter, and two Inches thick. Theſe were laid down on the Floor of my Chamber, ſo near together, that the Boy might ſtand with one Foot upon one, and the other upon the other Cake of Roſin: Then the Leaf-Braſs being laid under his Hands, the Tube rubb'd and held near his Legs, cauſed both his Hands to attract and repel the Leaf-Braſs to the Height of ſeveral Inches: Or if there was laid Leaf-Braſs under one Hand, and the Tube held near the other Hand, there was an Attraction communicated to the farther one; and when the Tube was applied either to his Hands or Feet, there was an Attraction given to his Cloaths; ſo that a Piece of white Thread being held by one End, the other End would be attracted at near the Diſtance of a Foot; ſo that the Attraction is altogether as ſtrong, if not ſtronger, than when the Boy was ſuſpended on Hair-Lines.

I come now to the above-mentioned Experiment: One of the Boys being ſuſpended on the Hair-Lines, and the other ſtanding upon the two Cakes of Roſin, the Boys holding Hands with each other, under the Boy's Hand that ſtood on the Roſin was laid the Leaf-Braſs; then the Tube being rubb'd, and held near the Boy's Feet that hung on the Hair-Lines, the Hand of the Boy that ſtood on the Roſin attracted ſtrongly. Then there was taken a four Foot Rule, and given to the Boys to hold by each End, and there was the ſame Vertue of Attraction given to the other Boy as before. After this a Line of Packthread was given them to take hold of by the Ends, and there was an Attraction

traction communicated from one End to the other, with as much Vigour as by any of the other Methods before mentioned. This Experiment was made *September* 13, 1732.

September 14 I firſt made the following Experiment. There was taken a Rod which was compoſed partly o Wood and partly Cane: It was twenty-four Feet in Length, and in Form not unlike two Fiſhing Rods ſuppoſed joined together at their bigger Ends. This Rod was ſuſpended Horizontal by two Threads of Silk: Over this, at about two Feet from the End, was ſuſpended a ſmall hazel Wand, about five Feet long, at right Angles to it, but not touching the Rod: Then going to the other End of the Rod, the Tube being excited and held near it, repeating the ſame three or four times as uſual, and going to the hazel Wand with a ſmall white Thread, I found that it was attracted to it when held near to any Part thereof. The next Day Mr. *Wheler* came to Mr. *Godfrey*'s, and now, by their Aſſiſtance, I repeated the Experiment, and we found that by ſuſpending the Wand at ſeveral Heights, we could perceive there was an Attraction, when it was at the Height of more than twelve Inches. I ſhall now give ſome Account of my repeating, and what farther Improvements I have made to ſome of theſe Experiments ſince my Return to *London*.

September 29th I repeated the Experiment on two Boys, firſt ſetting one of them on Cakes of Roſin, and the other being ſuſpended on the Hair-Lines, and the Effect was the ſame as hath been above related. I then cauſed both the Boys to ſtand on Cakes of Roſin, giving them to hold a Part of a *Spaniſh* Cane-

Fiſhing-

Fiſhing-Rod that was eight Foot long, one Boy holding one, and the other Boy the other End of the Rod; then the Leaf-Braſs being laid on the Stand, and one of the Boys holding his Hand over it; I went to the other Boy, and the excited Tube being held near the Palm of his Hand, the firſt Boy's Hand attracted and repelled the Leaf-Braſs ſtrongly. Then there was a Piece of Packthread given them to hold by each End, about the ſame Length with the Rod, *viz.* eight Feet long. Under each of their Hands was laid Leaf-Braſs; then going to the middle of the Line, holding the Tube near it, the farther Hand of both the Boys attracted the Leaf-Braſs with ſo much Vigour, that it is not to be doubted that had the Line been much longer, they would have attracted at a far greater Diſtance. I then cauſed the Boys to ſtand on the Cakes of Roſin, ſo as to let the Flaps of their Coats touch, and then by holding the Tube to one of their Hands, the other Hand attracted, but not with more Force than when they were diſtant the Length of the Line. Then they ſtood ſo much farther as not to let their Coats touch by about an Inch, and then exciting one of them to attract, the other received not the leaſt Degree of Attraction. I then bid one Boy put his Finger upon the other Boy's Wriſt, and then he immediately became Electrical.

October the 4th I made the following Experiment: A Fiſhing-Rod of about ten Feet eight Inches long, being horizontal, and over it, towards the leſſer End, a ſmall Rod, being the Top End of another Fiſhing Rod, at the leſſer End, which was Whale-Bone, there was put on a Ball of Cork two Inches Diameter,

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the ſmall Rod touching the great one; then the Tube being excited, and held near the great End of the great Rod, applying it as uſual; then going to the Cork with a pendulous Thread, I found it attracted it at the Diſtance of at leaſt two Inches. Then the Rod was moved higher, ſo as not to touch the End of the long Rod, by Eſtimation about an Inch, and after ſeveral Trials, there was a viſible Attraction, when the little Rod that carried the Ball was above the great one thirty-four Inches.

October the 5th, I took a Line of Packthread ſeventeen Feet four Inches long, with ſilk Lines tied to the Ends of the Packthread, one of them about four the other two Feet long, near two of the oppoſite Corners of my Chamber, where in each of them was drove a Hook at about three Foot and a half high, to which the Ends of the Silk were faſtened, drawn ſo tight as to bear the Packthread nearly Horizontal: Then the ſmall Part of the Fiſhing-Rod was ſuſpended over the Packthread at about four Feet from the End; then the Tube being applied to the other End of the Packthread, the Cork Ball at the End of the little Rod was attractive, and at ſeveral Removes, to the Height of forty-ſeven Inches, there was a viſible Attraction of the pendulous Thread.

October the 6th, inſtead of the ſmall Rod, I took a Packthread about four Feet long, and having tied ſilk Threads to each End, by which the Thread was ſuſpended over the longer Line Horizontal, and at right Angles nearly to the ſaid Line, which was by tying the Ends to perpendicular Lines of Packthread that were faſtened to Hooks at each End, and had ſliding Knots on them, ſo that the croſs Line might be moved

moved higher or lower as there was Occaſion for it; upon one End of this Line I put a Ball of Cork, and found, that when the firſt Line had been excited the Vertue was carried up to the ſecond Line, and cauſed the Cork Ball to attract. I then took off the Cork Ball, and put one of Ivory in its Place, and this attracted after the ſame manner; and afterwards I hung two Ivory Balls, one at one End, and the other at the other End of the Line, and found there was a ſenſible Attraction when the Line that ſupported them was raiſed thirty-eight Inches above the Line of Communication.

October the 30th I repeated this Experiment, and now when the Line that ſupports the Ivory Balls was elevated about an Inch above the communicating Line, either Ball attracted the Thread at the Diſtance of more than a Semi-diameter of the Ball, and at the Height of ten Inches, at leaſt half the ſame Diſtance.

By theſe Experiments we find, that the Electrick Vertue may not only be carried from the Tube by a Rod or Line to diſtant Bodies, but that the ſame Rod or Line will communicate that Vertue to another Rod or Line that is at a Diſtance from it, and by that other Rod or Line the Attractive Force may be carried to other diſtant Bodies. I am,

SIR,

Yours, and the Royal Society's,

Moſt Obedient Humble Servant,

Stephen Gray.

Charter-Houſe,
Oct. 15, 1732.

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LETTER II.

SIR,

THE Subject of Electrical Attraction at a Diſtance, without any Contact of the Line of Communication either by the Tube, or the ſaid Line not touching the Attracting Body, being ſo very ſurprizing, I preſume the following Account of the Experiments I have ſince my laſt made on that Subject, may not be unacceptable to the Society.

A ſmall Hoop of about twenty Inches Diameter, and an Inch and a half in Breadth, being ſuſpended by two Threads of Silk, ſo as that it hung perpendicular, and in a Plane at right Angles to the horizontal Line of Communication, which paſs'd through, or at leaſt very near to the Center of the Hoop, I went to the End of the ſaid Line, and applying the excited Tube near it, there was an attractive Influence communicated to the Hoop in all Parts of it. Then by a Skrew-Hole made in the Side of the Hoop for that Purpoſe, I ſkrewed it upon the Top of a Pedeſtal that was about two Feet and a half in Height, ſetting it upon a Cake of Roſin, ſo as that the before mentioned Line might paſs through the Center of the Hoop, and found that whether the Hoop was placed ſo as its Plane was at right Angles, or in any other Angle with the Line of Communication, the Hoop attracted after the ſame manner as it had done when ſuſpended on the ſilk Lines.

Some time after I made the following Experiment. Into the Noſe of a Glaſs Funnel I put the larger

End of the Top of a ſmall Fiſhing-Rod, and upon the leſſer End a Ball of Cork; then the Funnel was ſet on the Floor of the Room ſo as that the Rod was at ſome Inches diſtance from the Line of Communication; then the Tube being excited, and applied near the End of the Line, the Electrick Vertue was conveyed by it to the Cork Ball, and it attracted ſtrongly when the Ball was, by Eſtimation, not leſs than two Feet Diſtance from the aforeſaid Line.

December 11, there being a hard Froſt, and a fair Day, I repeated the Experiment, making uſe of a large Hoop that was about forty Inches Diameter, and ſetting it perpendicular upon a hollow Cylinder of Glaſs, which was ſix Inches long, and five Inches and a half Diameter, ſo placing the Hoop that the Line of Communication might paſs through, or at leaſt very near to the Center of the Hoop; then applying the Tube to the End of the Line, there was an Attraction communicated to all Parts of the Hoop, attracting a pendulous white Thread at the Diſtance, by Eſtimation, of about half an Inch. I then ſet the Hoop ſo as the inward Surface of the Hoop might touch the Line, and then communicating an Attraction by the excited Tube to the Packthread, the attractive Vertue was carried by it to the Hoop, and cauſed it to attract with that Force, as with the remoteſt Part of the Hoop to attract the Thread at a Diſtance, by Eſtimation, of about four Inches.

Some time after the 'foregoing, I made the following Experiment. The large Hoop being ſet upon the Glaſs Cylinder, and the Packthread paſſing through, or near its Center, the Tube being applied near

near the Hoop gave it a ſtrong Attraction, ſo that it would attract a Thread at the Diſtance of ſeven or eight Inches, and at the ſame time there was an Attraction communicated to the Packthread. Then I ſuſpended an Ivory Ball, of two Inches Diameter, at the other End of the Packthread, and applying the Tube to the Hoop, there was an Attractive Vertue carried to the Ball, and it would attract the pendulous Thread at the Diſtance of near an Inch. I then placed the Ball in or near the Center of the Hoop, and now it was ſo far from being attracted, that it was repelled by the Ball, but was attracted by the Packthread paſſing to it in the Arch of a Circle, whoſe Center ſeem'd to be that of the Ball.

This is all that I have at preſent to communicate, who am,

SIR,

The Society's, and your

Moſt humble Servant,

Stephen Gray.